

Heterogeneity in Chromate Conversion Coatings (CCC) on Al-Cu Alloy AA2024-T3 used for Aerospace Applications

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It is well known that coating systems consisting of a chromate conversion layer and multilayer polymer coatings provide the primary defense against environmental degradation of Al alloys in many aerospace applications. The objective of the present work is to analyze the interfacial and surface chemistry of a complex coating system. Previously, workers at Stony Brook^[1] as well as Hagans and Hass^[2] have reported that Cr concentration in the coating on intermetallics particles was different than that on the alloy matrix. The major issue that must be addressed is the spatial and depth-dependent chemical changes in the CCCs coatings.

In this experiment, Al-Cu alloy AA2024-T3 samples were treated with Sanchem 1000 (a commercial deoxidizing/degreasing treatment) and coated with 54 mg²/ft weight CCC according to industry practice. Dynamic and Static Secondary Ion Mass Spectrometry (D-SIMS and S-SIMS) were performed on the two weight CCCs. Dynamic profiles and Static SIMS chemical maps were created. To verify the SIMS results; CCCs and Argon ion etched CCCs were analyzed at port U10B of the National Synchrotron Light Source (NSLS). Small spot (< 5 microns) Synchrotron Infrared Microspectroscopy (SIRMS) was used to create chemical maps of the stretching frequencies for cyanno groups and chromate in the CCC. The bright, coherent synchrotron IR source allows these CCCs to be characterized with greater sensitivity and resolution than through the use of conventional black body source FTIR configurations.

Figure 1, show SIRMS maps of chromate and cyanno-compound within a CCC from the outer most surface of a 54 mg²/ft CCC on AA2024-T3. The S-SIMS and D-SIMS work showed that there is an inhomogeneous spatial distribution of the cyanno-compound and chromate in the CCC. **Figure 2** shows SIRMS maps from a 54 mg²/ft CCC on AA2024-T3 after 30 minutes ion etching with an Ar⁺ ion beam at 3 kV and 3 mA current. After etching, it is observed that some regions of the AA2024-T3 surface are not covered or barely covered by the CCC, while some parts are still well covered by the CCC.

The heterogeneity of the coatings found by D-SIMS and S-SIMS was confirmed by the distribution of cyanno-compounds, organics and chromate within a CCC by means of SIRMS. Data indicates that there are variations in the depth and spatial distribution of these species on the coated sample surfaces, which may be associated with the presence of underlying intermetallic compounds inclusions. The U. S. Air Force Office of Scientific Research under contract 79F49620-96-1-0479 supported this work.

References: [1] G.P. Halada, C.R. Clayton, M.J. Vasquez, J.R. Kearns, M.W. Kendig, S.L. Jeanjaquet, G.G. Peterson, G. Shea McCarthy, G.L. Carr, G.P. Williams, and L.M. Miller, (1999) "Spatially-Resolved Microchemical Analysis of Chromate Conversion Coated Aluminum Alloys and Constituent Intermetallic Particles," Critical Factors in Localized Corrosion III-In Honor of Jerome Kruger 70th Birthday, The Electrochemical Society, Pennington, NJ; [2] Hagans, P. and Haas, C.M., Surface Interface Analysis, 21, 65 (1994)

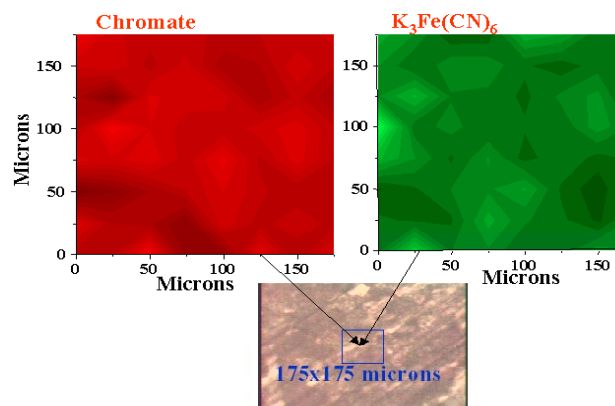


Figure 1. Chromate and CN SIRS maps of 54 mg²/ft CCC on AA2024-T3 (lighter regions indicate higher concentrations of the species).

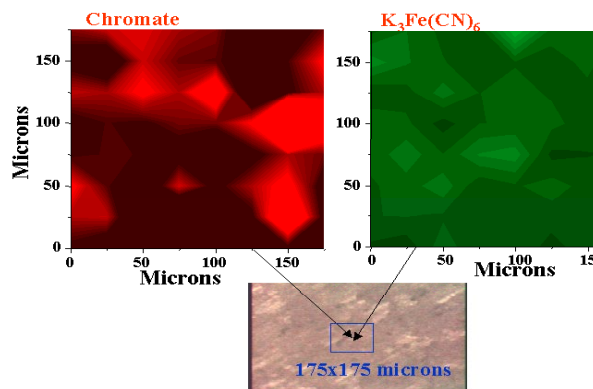


Figure 2. Chromate and CN SIRS maps of 54 mg²/ft CCC on AA2024-T3 following 30 minutes Ar⁺ ion etch (lighter regions indicate higher concentrations of the species).